A Framework for Evaluating the VISSIM Traffic Simulation with Extended Range Telepresence

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Abstract

This paper presents a novel framework for combining traffic simulations and extended range telepresence. The real user's position data can thus be used for validation and calibration of models of pedestrian dynamics, while the user experiences a high degree of immersion by interacting with agents in realistic simulations.

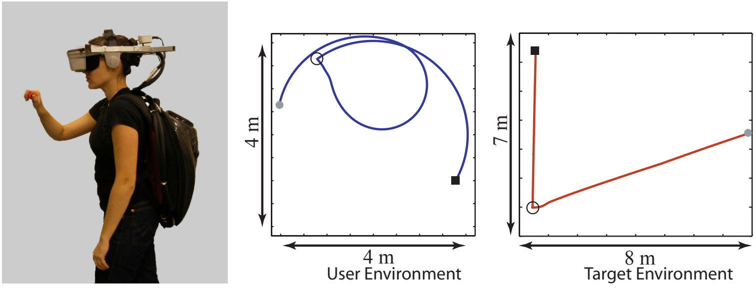
Keywords: Extended Range Telepresence, Motion Compression, Traffic Simulation, Virtual Reality

1 Introduction

The simulation of traffic flow was an early application of computer technology. As the computational effort is larger for the simulation of pedestrian flows, this followed later, beginning in the 1980s and gaining increasing interest in the 1990s. Today, simulations are a standard tool for the planning and design process of cities, road networks, traffic signal lights, as well as buildings or ships.

Telepresence aims at creating the impression of being present in a remote environment. The feeling of presence is achieved by visual and acoustic sensory information recorded from the remote environment and presented to the user on an immersive display. The more of the user's senses are telepresent, the better is the immersion in the target environment. In order to use the sense of motion as well, which is specially important for human navigation and way finding (Darken et al., 1999), the user's motion is tracked and transferred to the *teleoperator* in the *target environment*. This technique provides a suitable interface for virtual immersive simulations, where the teleoperator is an avatar instead of a robot (Rößler et al., 2005). As a result, in extended range telepresence the user can additionally use the proprioception, the sense of motion, to navigate the avatar intuitively by natural walking, instead of using devices like joysticks, keyboards, mice, pedals or steering wheels. Fig. 1(a) shows the user interface in the presented telepresence system.

Our approach combines realistic traffic simulations with extended range telepresence by means of Motion Compression (Nitzsche et al., 2004). We will first shortly sketch the two subsystems: Motion Compression and the traffic simulation. Then, an overview of the system as a whole will be presented, as well as a short experimental validation. Finally, the potentials of the system in various fields of application will be discussed.



(a) (b)

Figure 1: (a) User interface in the extended range telepresence system. (b) The corresponding paths in both environments.

2 Motion Compression

In order to allow exploration of an arbitrarily large target environment while moving in a limited user environment, Motion Compression provides a nonlinear transformation between the desired path in the target environment, the *target path*, and the *user path* in the user environment. The algorithm consists of three functional modules.

First, the *path prediction* gives a prediction of the desired target path based on the user's head motion and on knowledge of the target environment. If no knowledge of the target environment is available, the path prediction is based completely on the user's view direction.

Second, the *path transformation* transforms the target path into the user path in such a way, that it fits into the user environment. In order to guarantee a high degree of immersion the user path has the same length and features the same turning angles as the target path. The two paths differ, however, in path curvature. The nonlinear transformation found by the path transformation module is optimal regarding the difference of path curvature. Fig. 1(b) shows an example of the corresponding paths in both environments.

Finally, the *user guidance* steers the user on the user path, while he has the impression of actually walking along the target path. It benefits from the fact that a human user walking in a goal oriented way constantly checks for his orientation toward the goal and compensates for deviations. By introducing small deviations in the avatar's posture, the user can be guided on the user path. More details can be found in (Nitzsche et al., 2004; Rößler et al., 2004).

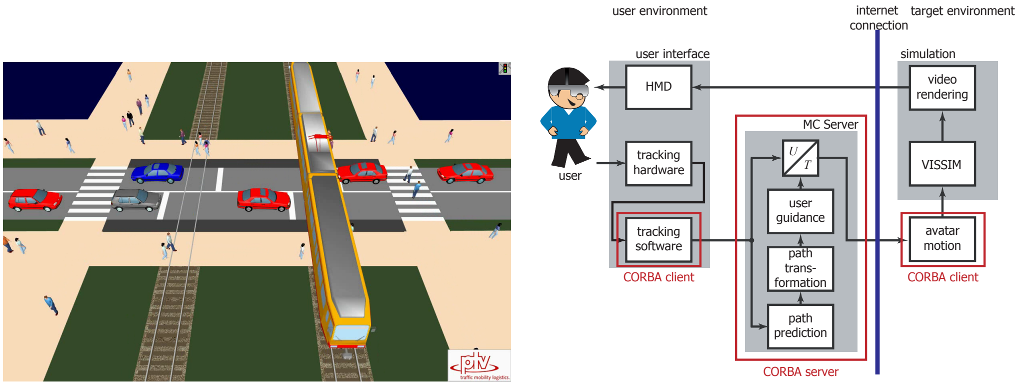
3 VISSIM

VISSIM (Fellendorf and Vortisch, 2001; PTV, 2008) is a multi-modal microscopic traffic flow simulator (fig. 2(a)) that is widely used for traffic planning purposes like designing and testing signal control (see (Fellendorf, 1994) as an example) and verifying by simulation that an existing or planned traffic network is capable of handling a given or projected traffic demand as in (Keenan, 2008).

Recently the simulation of pedestrians has been included in VISSIM. The underlying model is the Social Force Model (Helbing and Molnar, 1995; Helbing et al., 2000).

4 Connecting VISSIM to the Extended Range Telepresence System

The integration of telepresence and VISSIM has been made to exchange data, such that the scene shown to the user is populated with agents (pedestrians) from the VISSIM simulation. The user is blended into the VISSIM simulation such that the agents in the simulation react on him and evade him. In order to be able to control the avatar according to the user's head motion, the user's posture is recorded and fed into the Motion Compression server. Every time an update of the user's posture is available, the three steps of the algorithm are executed as described in section 2. Motion Compression transforms finally the user's posture into the avatars's desired head posture.

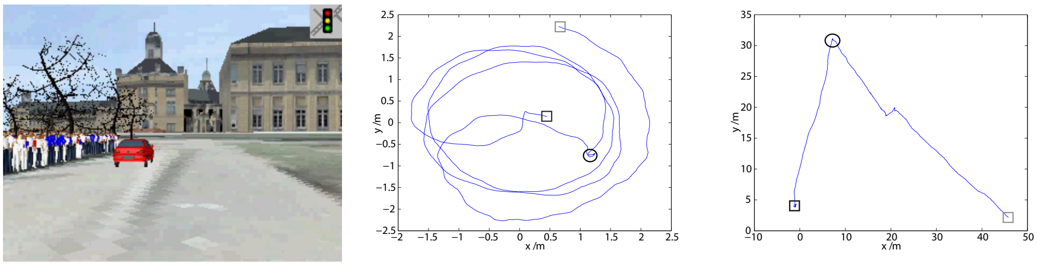


(a) (b)

Figure 2: (a) A snapshot from a VISSIM animation. (Animation online at (PTV, 2008)). (b) Data flow in the proposed telepresence system.

The desired head posture is now sent to VISSIM through an internet connection. The simulation constantly captures live images, which are compressed and sent to the user. Fig. 2(b) shows the whole data flow.

5 Experimental Evaluation



(a) (b) (c)

Figure 3: (a) Impression of the tested scenario. (b) Path in the user environment. (c) Path in the target environment.

The setup uses a high quality head-mounted display of 1280×1024 pixels per eye and a field of view of 60°. The user's posture, i.e., position and orientation, is estimated by an acoustic tracking system that provides 50 estimates per second (Beutler and Hanebeck, 2005). For testing the framework, an environment known to the users was chosen for the VISSIM Simulation. The users were asked to walk from the Karlsruhe Schloss to the ISAS lab's building. The completion time was very similar to the time needed for walking the real path. It is remarkable that the users' velocity increased during the experiment. This indicates that after a couple of minutes of adjustment the user adapts to the system and is able to navigate intuitively through the target environment. An example of the recorded paths in both environments during a test run is shown in fig. 3(b) and 3(c).

6 Conclusions and Outlook

The presented setup is the first step demonstrating the possibilities of the complete system, which provides a unit for first person simulation testing. The extended range telepresence system can be also used for experiments on pedestrian dynamics, since much less data is available for pedestrians than for vehicles, especially highway traffic, and the currently available data is by far not sufficient for validation and calibration of models of pedestrian dynamics. These experiments in the virtual environment are not only cheap to be set up, but also quick to evaluate, as all positions of the user are available in the system. Having one real person moving through a crowd of simulated agents might also be a good supplement to the validation method proposed in (Hoogendoorn and Daamen, 2007), where one agent is simulated in an environment of data of real pedestrians' movements.

Applications of extended range telepresence in pedestrian simulations include visiting virtual museums and virtual replications of cities or historic buildings. An application with particular focus on gaining spacial knowledge is the simulation of emergency evacuations, where people are trained to find the way out of buildings.

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